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GB 1308043 A GB 0833869 A EP 0499191 A1
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(54) BAND CLAMP

(57) A clamp disclosed comprising at least two clamping members (40) with concave, resiliently deformable inner faces shaped to conform to a pipe, riser or similar. In use, the clamping members (40) are placed around the pipe and are surrounded and secured in place by an elastically stretchable compression band (42). The clamp is particularly suited for use in securing buoyancy modules on flexible risers used in oil and gas extraction.

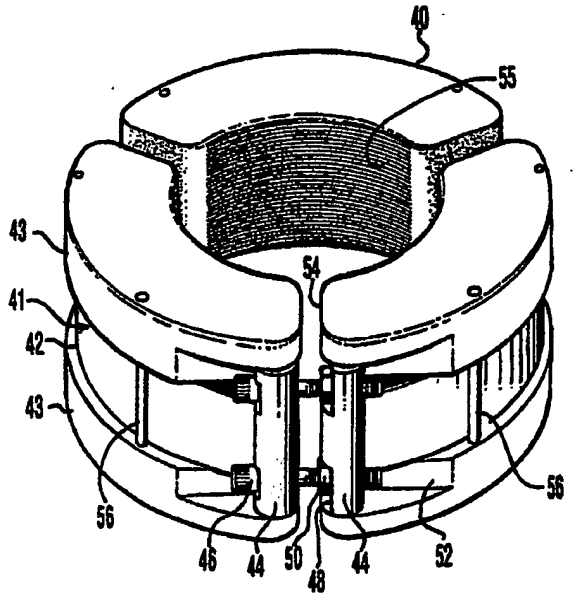

FIG. 6

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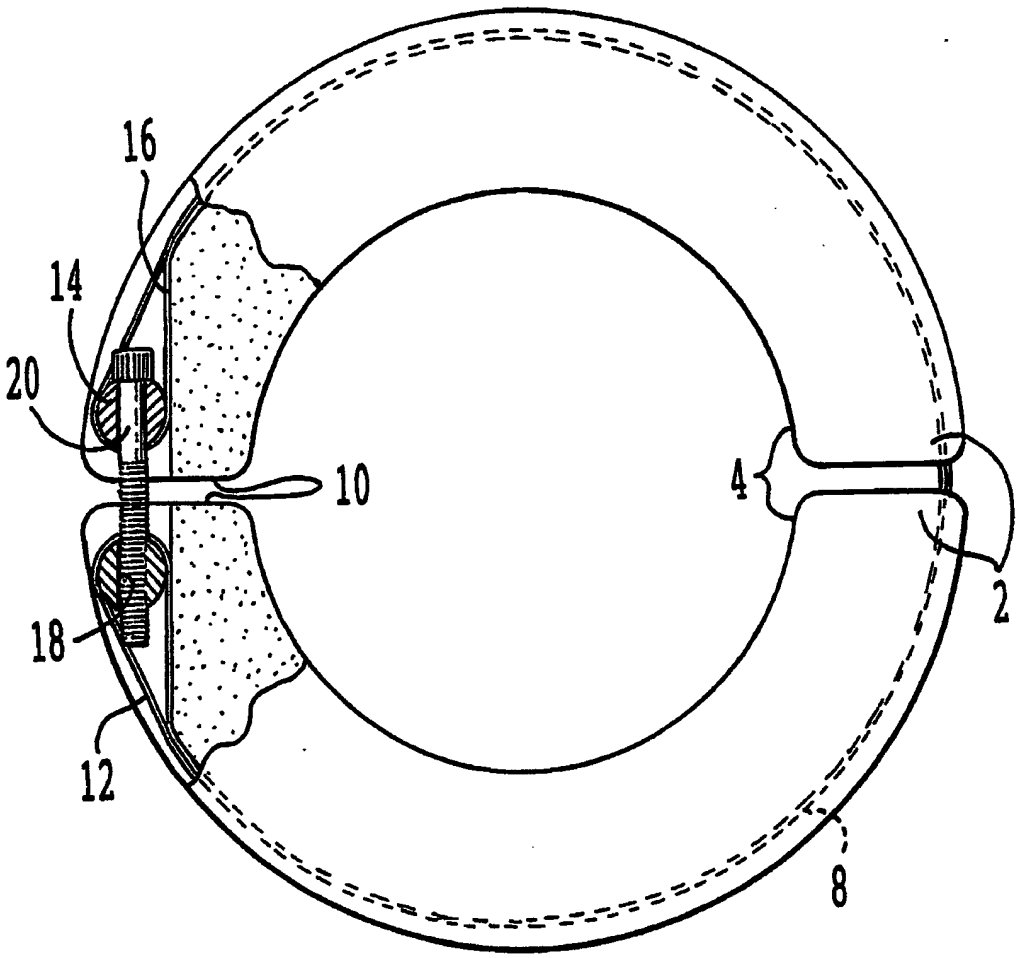

FIG. 1

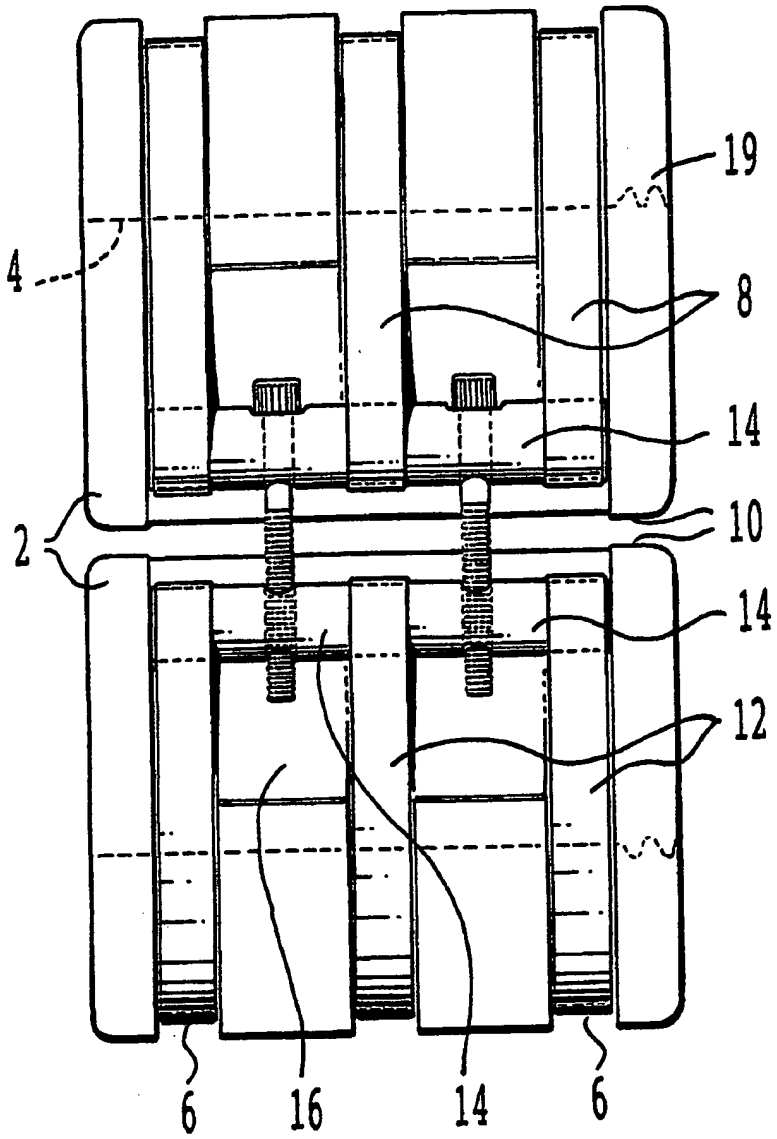

FIG. 2

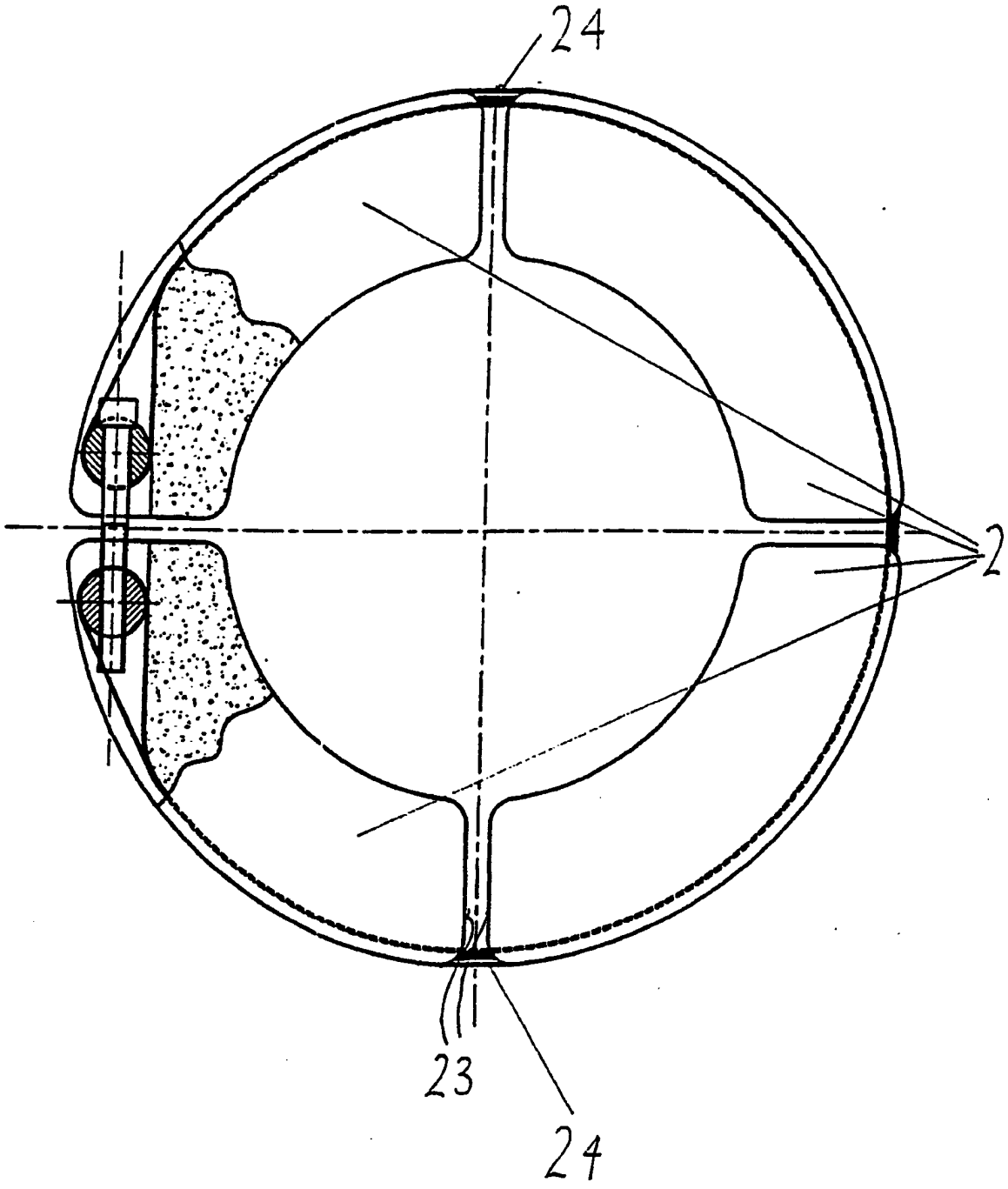

FIG. 3

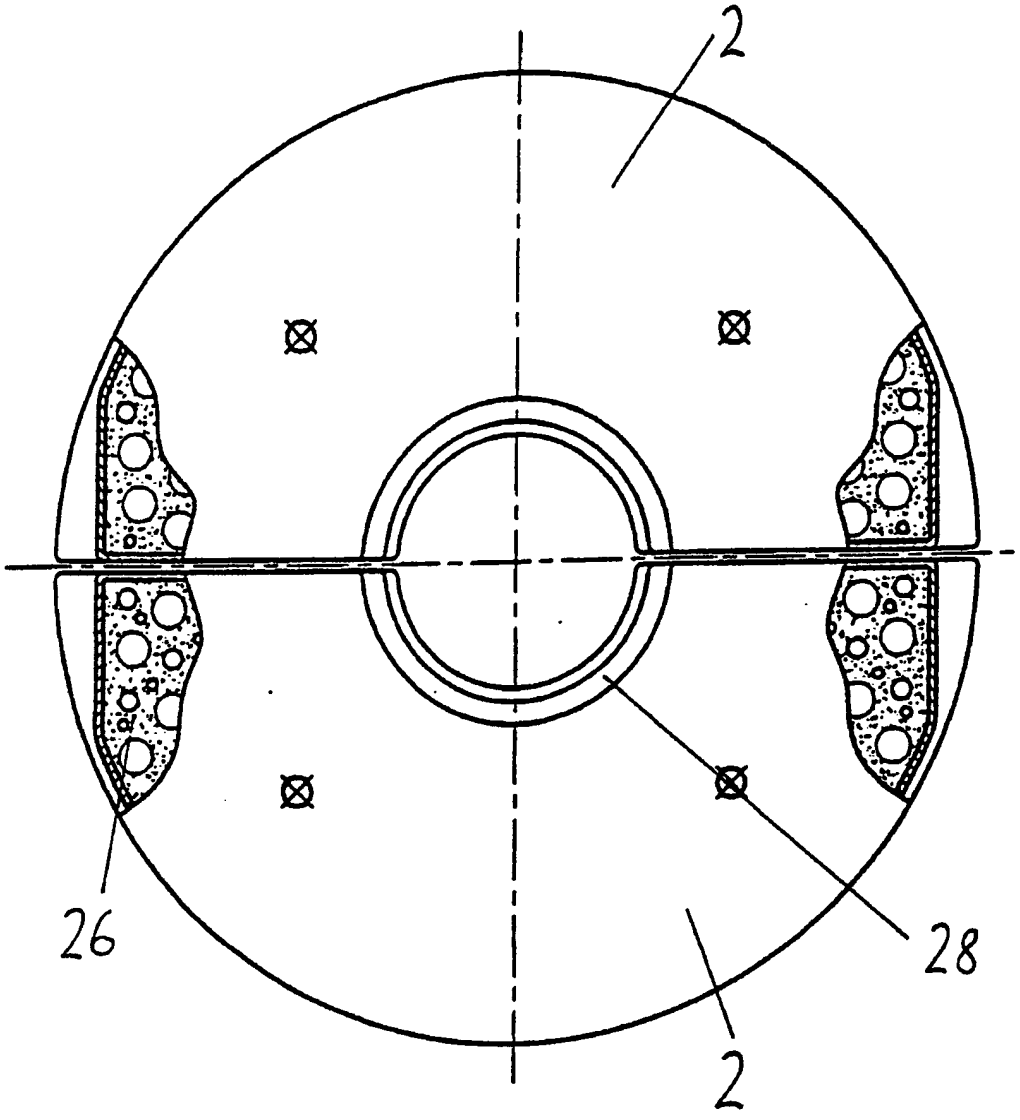

FIG.4

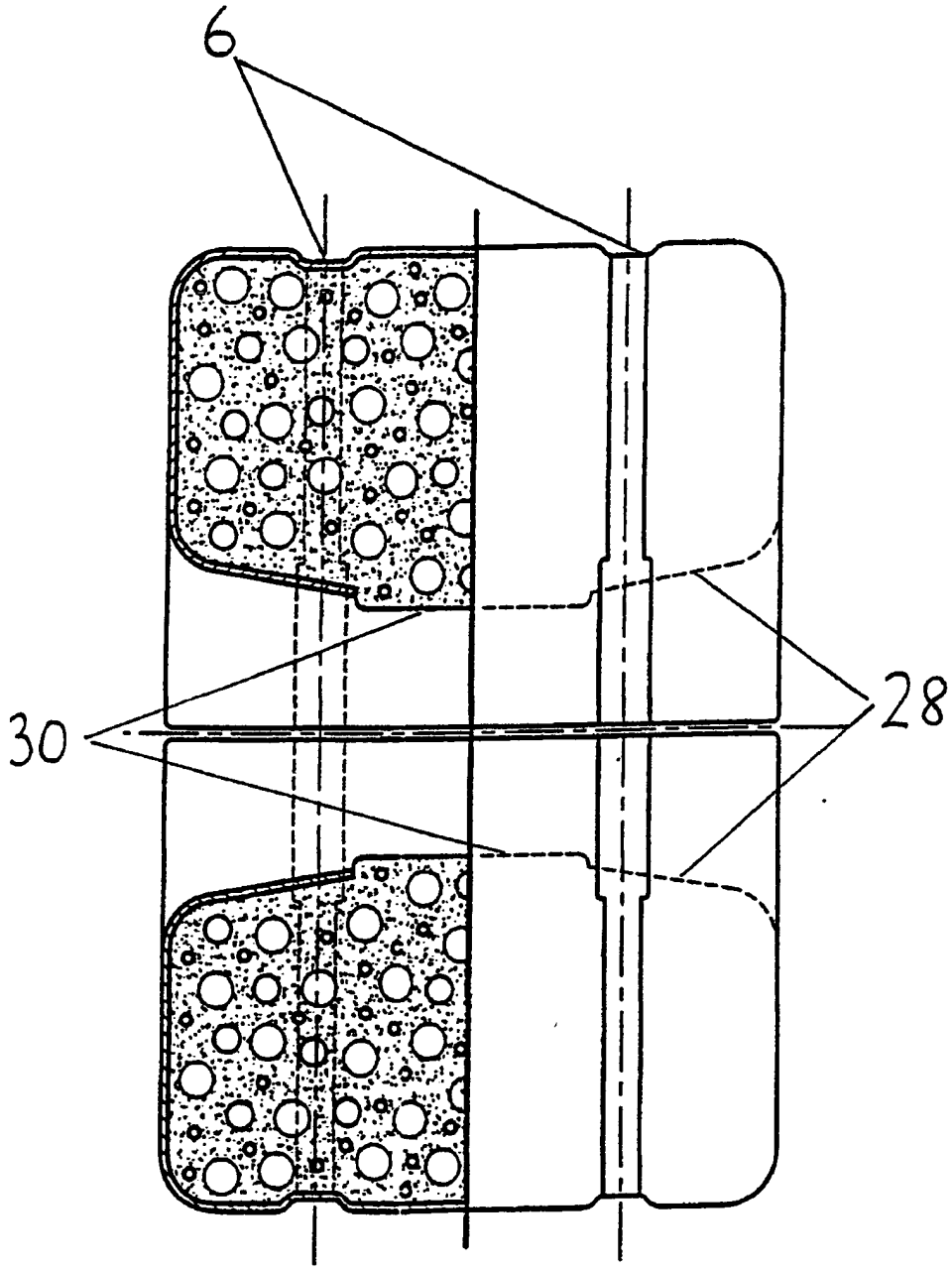

FIG. 5

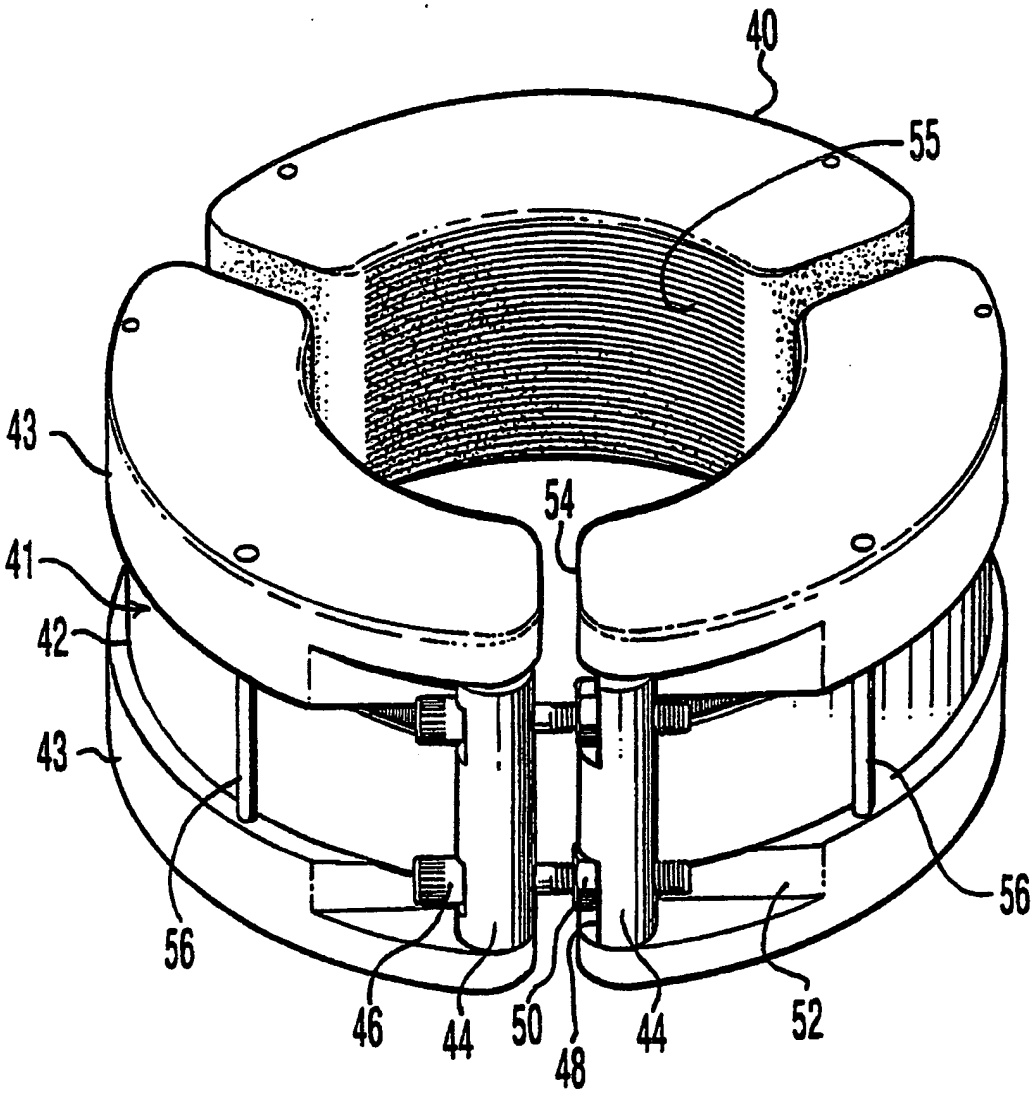

FIG. 6

DESCRIPTION

CLAMP

This invention relates to clamps, and in particular to a clamp for making a secure mechanical connection to the outside of a cylindrical member such as a pipe. It is particularly suitable for securing a buoyancy module to a flexible riser of the type used in the offshore oil and gas industry.

Oil and gas extracted at sea are carried from the seabed to the surface by flexible risers, which are composite steel structures in the form of pipes with diameters ranging from approximately 10cm to approximately 50cm.

A widely used form of riser is a composite structure containing an inner interlocked steel carcass surrounded by one or more layers of:-

i. thermoplastic sheathing;

ii. interlocked steel, contributing rigidity;

iii. crosswound tensile armours of steel wire.

This produces a structure which is flexible, resistant to internal and external pressure and waterproof. The outermost layer is typically a thermoplastic sheath.

The outside diameter of risers of this type is subject to a significant tolerance. The outside diameter varies from one riser to another, and along the length of a given riser. It also varies in

response to the hydrostatic pressure of the surrounding water and to the pressure exerted by the gas or oil within the riser.

It is frequently necessary to provide underwater buoyancy modules on a riser, providing it with support and so maintaining the riser in the correct shape in the water. A known form of buoyancy module comprises two flotation members, which are substantially "C" shaped in cross section and in use are secured together to form a cylindrical buoyancy module surrounding a section of the riser.

To prevent the buoyancy module from moving along the length of the riser despite the upward force exerted on them because of their buoyancy, it is known to securely locate them on the riser by means of a clamp.

A known form of clamp comprises two "C" shaped aluminium clamping members which have an internal concave curvature equal to the external curvature of the riser and which are adapted to be joined together, surrounding a section of the riser, by means of bolts. Tightening the bolts causes a compressive force to be exerted on the riser by the clamp, which is thereby secured in place. The buoyancy module is assembled around the riser and the clamp, the clamp being contained in an annular recess within the buoyancy

module, which is thereby prevented from moving along the riser.

Clamps of this known type suffer from several disadvantages:

1. There are several processes involved in the manufacture of the known clamps. They must be cast, heat treated, machined and finally painted. They are therefore expensive.

2. To make a sufficiently secure connection to the riser, the internal curvature of the aluminium clamping members must accurately match the external curvature of the riser. Since the external diameter of the riser is subject to a large tolerance, the clamping members must be individually machined to fit a particular section of the riser. This means that the clamps cannot be machined and painted until the riser has been manufactured and measured, and that they must subsequently be mounted on the correct section of a particular riser. It also adds to the cost of the clamps.

3. The known clamps comprise a large volume of aluminium and are therefore heavy, requiring additional buoyancy to support their weight.

4. The corrosion performance of the aluminium over an extended design life (20 years is typical) in a salt water environment is questionable. It will be

appreciated that a component used in an inaccessible underwater environment should require very little maintenance.

5. The external diameter of the riser can change due, for example, to creep of the metal of the riser, or to changes of temperature or of internal or external pressure. This can allow the clamp and its associated buoyancy module to move upwards along the riser. It is even possible for one buoyancy module to collide with and dislodge a second and further modules.

A known method of partly overcoming problem (5) is to provide disc springs which act to force the two clamping members together and to allow for some relative movement of the two clamping members, but these suffer from corrosion and attack by marine growth, which can prevent said relative movement.

In accordance with the present invention, there is provided a clamp comprising at least two clamping members, each of which has a concave inner surface, and a compression band which is elastically stretchable and is adapted to surround both or all of said clamping members and to exert a compressive force thereon.

Because of the elasticity of the compression band, pressure of the clamping members upon the riser

is maintained despite contraction of the riser. Further, by initially straining the compression band, stretching thereof over time and expansion of the riser can be allowed for.

In a preferred embodiment, the clamping members are resiliently deformable.

In an alternative preferred embodiment, the clamping members comprise a substantially rigid material and the concave inner surfaces of the clamping members are provided with a resilient covering.

It is not necessary to individually machine the clamping members of the above embodiments to match a particular section of the riser. Instead, the clamping members or the resilient covering can deform to allow for small differences between the external curvature of the riser and the internal curvature of the clamping members, maximising the area of contact.

Preferably, the clamping members comprise a syntactic foam. This has the advantage that it can be produced with a specific gravity of 0.6, and therefore floats. The clamp in accordance with the invention thus requires no additional buoyancy to support it. Also, although it has a degree of resilience, it does not yield significantly under compressive stress, so the clamping members are not compressed over time.

Clamping members comprising syntactic foam can be formed by moulding, and are therefore quick and cheap to produce.

Preferably, the compression band comprises a metallic material, more preferably titanium.

Titanium is highly resilient: it can be subjected to strains as large as 20% without permanent deformation. Thus, for example, the clamp may be initially installed with the compression band subjected to 10% strain (ie. stretched to a length which is 10% greater than its unstressed length). Subsequently, an expansion at the outer diameter of the clamping members as large as 10% can be accommodated without permanently deforming the compression band, and pressure on the riser is maintained despite a substantial contraction thereof.

The preferred combination of materials, titanium and syntactic foam, produces a clamp which is highly resistant to corrosion and other types of degradation, even in salt water environments.

The concave inner surfaces of the clamping members are preferably shaped to conform to a cylindrical surface. In this way, the said faces are adapted to provide a maximum area of contact when the clamp is mounted on a cylindrical body such as a riser.

In a particularly preferred embodiment of the

present invention, the clamping members comprise a material which is less dense than water, and are of sufficient volume for the clamp to function as a flotation module. Still more preferably, the clamping members are of sufficient volume for the clamp to act as a flotation module for a riser of the type used in underwater extraction of oil or gas. In such an embodiment, the volume of the clamping members is enlarged

In a further preferred embodiment, the clamping members are linked by elastomeric joints. This facilitates assembly on the riser.

In an alternative embodiment of the present invention, retaining means are provided for securing the compression band to the clamping members. In this way, the compression band is used to flexibly secure the clamping members together.

Preferably, the outer surfaces of the clamping members each have a circumferential groove for receiving the compression band. In such an embodiment, the retaining means may take the form of at least one member disposed across the circumferential groove radially outward of the compression band.

Preferably, the concave inner surfaces of the clamping members have grooves or projections for

gripping.

A number of specific embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a part sectional side view of a first embodiment of the invention;

Fig. 2 is a front view of the embodiment shown in Fig. 1;

Fig. 3 is a side view of a second embodiment of the invention;

Fig. 4 is a side view of a third embodiment of the invention, in which the clamp is adapted to function as a buoyancy module in its own right;

Fig. 5 is a section through the embodiment shown in Fig. 4; and

Fig. 6 is a part sectional side view of a fourth embodiment of the present invention.

The embodiment shown in Figs. 1 and 2 comprises two substantially "C" shaped clamping members 2, which are formed of a resilient material such as syntactic foam. The clamping members have a concave inner surface whose cross section is a section of a circle of substantially the same diameter as the riser to which they are to be joined and, in this embodiment, a convex semicircular outer surface which is provided with three grooves 6 (see Fig. 2) for the purpose of

receiving 3 compression bands 8. The inner surfaces 3 are not a full semicircle, so that when the clamping members 2 are placed around a riser to which they are to be clamped, their end faces 10 are separated by a gap.

The compression bands 8 are formed of a material with a degree of elasticity, in this case titanium, and comprise loops 12 at both ends which may, for example, be formed by welding or by crimping the band to join it to itself.

Two tensioning bars 14 are passed through the loops 12, each bar being passed through three loops of three separate compression bands. When the clamp is assembled, the tensioning bars 14 rest on flats 16 on a portion of the outer surface of the clamping members 2 adjacent the end faces 10. The tensioning bars 14 are each penetrated by two radial bores 18 and may be drawn towards each other by means of two bolts 20 passed through said radial bores 18. The bolts may either be provided with nuts or, more preferably, may engage with screw threads in the radial bores 18 in one of the tensioning bars 14.

As Fig. 2 shows, a portion of the concave inner surface 4 of each of the clamping members 2 bears a screw thread 19.

In use, the clamping members 2 are placed around

a riser. The compression bands 8 are placed around the clamping members in their respective grooves 6. The ends of the compression bands 8 are linked by means of the tensioning bars 14 and the bolts 20, and the bolts 20 are then tightened, stretching the compression bands and exerting a compressive clamping force on the clamping members and the riser. The screw thread 19 helps to securely locate the clamp by biting into and so engaging with the thermoplastic covering of the riser.

A buoyancy module may then be assembled around the riser and the clamp, the clamp being contained in an annular recess within the buoyancy module and thereby securely locating it.

It is possible and, in some cases, preferable to provide more than two clamping members. By way of example, Fig. 3 shows a second embodiment of the invention comprising 4 clamping members 2.

In this embodiment, all but two of the end faces 23 of the clamping members 2 are joined by elastomeric joints 24 to facilitate assembly.

In this embodiment, the clamping members function in a similar way to the jaws of a chuck, and can therefore accommodate an increased range of riser-external diameters. It would be possible within the scope of the invention to provide still more clamping

members: a clamp comprising an increased number of clamping members is capable of accommodating an increased range of external diameters of the riser. In the case where the clamping members have a degree of resilience, the deformation of the clamping members necessary for them to conform to the profile of the riser is reduced as the number of clamping members is increased.

A third embodiment of the present invention is illustrated in Figs. 4 and 5. In this embodiment, the volume of the clamping members is increased, and instead of using a buoyancy module and a separate clamp, the clamp is adapted to function as a buoyancy module in its own right.

As in the previous embodiments, the clamping members 2 comprise a syntactic foam 26. Two clamping members 2 are provided in this embodiment, although this number could be increased as in the second embodiment.

Compared with the first two embodiments, this clamp is increased both in width and in external diameter, producing the required increase in volume.

The concave inner faces of the clamping members 2 comprise outer tapered portions 28 and central parallel contact portions 30, which contact the surface of the riser in use.

As in previously described embodiments, the outer surfaces of the clamping members 2 comprise grooves 6 (in this case two of them) to receive the compression bands.

A fourth specific embodiment of the present invention is illustrated in Figs. 6. This embodiment comprises three clamping members 40, a number of clamping members which is particularly preferred.

The present embodiment has a single, broad compression band 42 surrounding the clamping members 40. The outer surface of each clamping member has two outer flange portions 43 between which is defined a circumferential groove 41 to receive the compression band 42. The two ends of the compression band 42 are not provided with loops, as in the previously described embodiments, but are welded directly to respective first and second tensioning bars 44. The weld lines between the compression band 42 and the tensioning bars 44 lie parallel to the longitudinal axes of the tensioning bars 44.

As in previously described embodiments the tensioning bars 44 each have two through going transverse holes to receive respective bolts 46, whereby the two tensioning bars 44 may be joined and drawn together, tightening the compression band 42 around the clamping members 40. In the present

embodiment two flats 48 are machined on the first of the tensioning bars 44, in the region where the through going holes exit the tensioning bar, to abut against locking nuts 50 screwed onto the bolts 46.

The locking nuts 50 serve not only to prevent the bolts 46 from working loose after assembly of the clamp, but also to retain the two bolts 46 on the second of the tensioning bars 44 before the clamp is assembled, thereby preventing the bolts from being lost, and facilitating assembly. Ease of assembly is particularly important in underwater applications.

The outer surfaces of two of the clamping members have respective recesses 52 adjacent their end faces 54 to receive the tensioning bars 44.
The inner, concave surfaces of the clamping members 40 each have a number of protuberant ridges in the form of a screw thread 55 which, in use, bite into the sheathing of a riser, helping to secure the clamp in place.

According to the present embodiment, retaining means are provided for retaining the compression band 42 in the circumferential grooves 41 of the clamping members. In this way, all of the principal components of the clamp - the clamping members and the compression band - are retained together in a single assembly prior to mounting on a riser. Thus to mount

the clamp on a riser it is necessary only to position the assembly around the riser and to engage and tighten the bolts 46.

The retaining means take the form of nylon rods 56 which extend across the circumferential grooves 41. Both ends of the nylon rods 56 are received in axially extending holes in respective flange portions 43 of the clamping members, and are cemented in place using a silicone sealant. The nylon rods 56 lie radially outward of the compression band 42, thereby retaining it in the circumferential groove 41.

In the present embodiment, two nylon rods per clamping member are provided.

It will be appreciated that the retaining means could take a variety of other forms, provided that they fulfil the function of retaining the compression band 42 at the outer surfaces of the clamping members 40.

CLAIMS

1. A clamp comprising at least two clamping members, each of which has a concave inner surface, and a compression band which is elastically stretchable and is adapted to surround both or all of said clamping members and to exert a compressive force thereon.

2. A clamp as claimed in claim 1, wherein the clamping members are resiliently deformable.

3. A clamp as claimed in claim 1, wherein the clamping members comprise a substantially rigid material and the concave inner surfaces of the clamping members are provided with a resilient covering.

4. A clamp as claimed in any preceding claim, comprising a syntactic foam.

5. A clamp as claimed in any preceding claim, wherein the compression band comprises a metallic material.

6. A clamp as claimed in claim 5, wherein the compression band comprises titanium.

7. A clamp as claimed in any preceding claim, wherein the concave inner surfaces of the clamping members are shaped to conform to a cylindrical surface.

8. A clamp as claimed in any preceding claim, wherein the clamping members have circumferential grooves for receiving the compression band.

9. A clamp as claimed in any preceding claim, wherein the clamping members are linked by elastomeric joints.

10. A clamp as claimed in any of claims 1 to 8, wherein retaining means are provided for securing the compression band to the clamping members.

11. A clamp as claimed in claim 8, provided with retaining means comprising at least one member mounted across the circumferential groove outside the compression band.

12. A clamp as claimed in any preceding claim, wherein the compression band is adapted to be tightened by means of at least one threaded member.

13. A clamp as claimed in any preceding claim, wherein the clamping members comprise a material which is less dense than water and are of sufficient volume for the clamp to function as a flotation module.

14. A clamp as claimed in claim 13, wherein the clamping members are of sufficient volume for the clamp to function as a flotation module for a riser of the type used in underwater extraction of oil or gas.

15. A clamp substantially as herein described with reference to, and as illustrated in, the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9506584.3
Relevant Technical Fields (i) UK Cl (Ed.N) E2A (AGME, AGW, AGUB, AGEA, AGEB) (ii) Int Cl (Ed.6) F16B 2/08	Search Examiner A ANGELE
	Date of completion of Search 27 JUNE 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- ALL

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Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1308043 A	(HYMATIC)	1, 2 at least
X	GB 833869 A	(SMITH)	1, 2 at least
X	EP 0499191 A1	(SCHEMM)	1, 2 at least
X	US 4128921 A	(HEINZE)	1, 2 at least

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